clusions of much interest. He was also able to show, both in the frog and mammal, the influence of the mid-brain upon those movements.

One of the most important pieces of work here recorded is that in which Martin experimentally determined that the internal intercostal muscles are expiratory in their function throughout their whole extent, thus finally settling a question which had divided physiologists ever since physiology was recognised as a science. This he was enabled to do not by experiments upon models, nor upon the cadaver, but by direct observation in the living animal; a method which will always remain the only satisfactory one for solving such problems.

The physiologists of this country owe a debt of gratitude to their American colleagues for having provided them in so handsome a form with this important collection of monographs. E. A. SCHÄFER.

OUR BOOK SHELF.

Atlas d'Ostéologie. Articulations et Insertions Musculaires. By Prof. Ch. Debierre. Pp. viii + 92. (Paris: Alcan, 1896.)

THIS atlas contains 88 plates with 251 figures illustrating the human skeleton. Figures are also given to illustrate the ligaments of the various joints, and, further, for each bone the muscular attachments are indicated by red printing. The mode of development and microscopic of bone are illustrated by five figures, and in a few cases a certain amount of comparative osteology is introduced. The figures are by no means better than those given in the standard text-books, and it is a pity that no mention is made in each case of the amount of reduction or magnification made in the drawing. Some of the figures are very confused, and the individual parts difficult to recognise. This is especially the case with such figures as the base of the skull with the soft parts left attached (Fig. 82). In many cases it seems a mistake that the figures have not been drawn on a larger scale, as much room is often wasted on the plates.

Mechanics for Beginners. By W. Gallatly, M.A. Pp. 253. (London: Macmillan and Co., Ltd., 1896.)

THE special characteristics of this book are stated to be (1) the large number of examples—eight hundred—of which one hundred and sixty are worked in full; (2) the great attention given to work, power and energy; (3) the classification, in small sections, of problems of the same type, the method of dealing with each section being explained by a worked example. Teachers of elementary theoretical mechanics will know how to appreciate these important qualities of the book. The descriptions are very clear, and the diagrams are helpful. The student who uses the treatise as a text-book, familiarising himself with the illustrative examples, and working through only a part of the well-selected and comprehensive exercises, will be equipped for almost any examination in elementary theoretical mechanics. And he will, at the same time, lay up in his mind a fund of useful knowledge.

Engineer Draughtsmen's Work. By a Practical Draughtsman. Pp. 96. (London: Whittaker and Co., 1896.)

STUDENTS in technical schools will find in this book a number of valuable hints on the use of mathematical instruments and the work of drawing-offices. The information is very elementary, but its character is such that it will train young draughtsmen to be accurate and methodical in their work.

Forty-eight pages of advertisement are bound up with the ninety-six pages of text.

LETTERS TO THE EDITOR.

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Flying Engines.

IN the summer of 1893, I made some experiments on the effect of steam-jacketing small steam-engine cylinders by placing the whole of the cylinder and valve chest inside the boiler; the increase of economy was so marked, that I was led to try whether a small toy engine could be made to sustain its own weight in the air by the lifting power of an air screw on the crank-shaft.

Fig. 1 shows this little engine. The boiler is of seamless steel $2\frac{1}{2}''$ diameter, 14" long, and ·01" to ·015" in thickness; the steam cylinder, single acting, $1\frac{1}{4}''$ diameter by 2" stroke, and about ·03 thickness of tool steel; the piston is of thin cup form, also of tool steel; the admission valve is cylindrical, $\frac{5}{16}''$ diameter, cutting off at $\frac{3}{4}$ stroke. The whole of the valve and cylinder are within the boiler. Some parts of the engine were soft soldered, and some hard soldered; the screw is of cane covered with silk. The working pressure was limited to about 50 lb. per square inch. The total weight of the apparatus, with water, as in Fig. 1, is $1\frac{1}{4}$ lb.

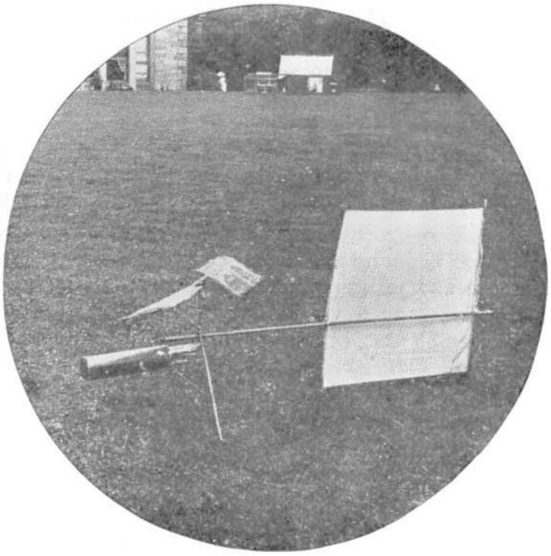

FIG. 1.—Steam engine and boiler working lifting screw; large plane to prevent rotation of boiler; total weight $1\frac{1}{4}$ lb. I.H.P. developed, $\frac{1}{4}$, Raised itself about 12 feet in the air, with steam contained in boiler. No firing after start. Initial pressure 50 lb. Maximum revolution about 1200 per minute.

Steam was raised by placing the boiler over a spirit-lamp, and when 50 lb. was registered on the gauge, and the engine started, it raised itself in the air vertically to a height of several yards. The revolutions of the engine were about 1200 per minute, and the i.h.p. $\frac{1}{4}$ horse-power.

The same engine was then mounted on a framework of cane, covered with silk, forming two wings of 11 feet span, and a tail, the total area being about 22 square feet. The total weight was now $3\frac{1}{2}$ lb., and when launched gently from the hand in an inclined horizontal direction it took a circular course, rising to a maximum height of about 20 feet. When the steam was exhausted, it came down, having traversed a distance of about 100 yards.

Fig. 2 shows the machine in mid-air. The photographs were taken by Mr. Gerald Stoney.

Considering the primitive construction of the apparatus, the result clearly showed that flights of considerable distance, possibly some miles, were quite possible with a small economical steam-engine mounted on aeroplanes.

The boiler was also found to be able to steam the engine continuously by using methylated spirits intead of water in the boiler,

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and burning the exhaust as fuel; but when in flight, the force of the wind extinguished the flame.

It was clearly seen by the experiment that for practical commercial success of this class of steam apparatus an air condenser is essential, as the weight of water used in a few minutes' run

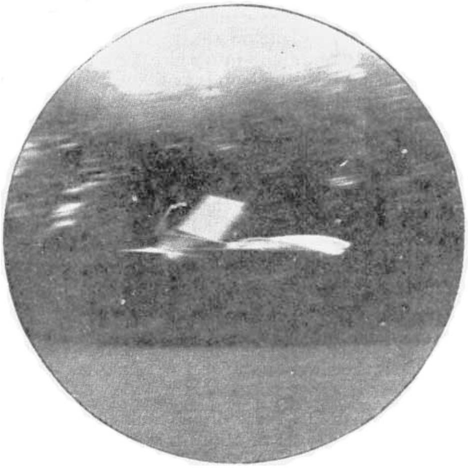

FIG. 2.—Same engine and boiler as before, attached to two inclined wing planes, and tail. From tip to tip of wings 11 feet; total surface of wings and tail about 22 square feet. Total weight of whole apparatus 3½ lb. Steam raised to 50 lb. per square inch, and started. Length of flight about 100 yards on level; maximum height during flight, about 20 feet. The propelling screw is seen in front and above the frame.

equals the total weight of engine and boiler. Without a condenser, the length of flight must necessarily be limited to a very few miles, and it would seem that the chief problem that workers in this field have to solve, is to obtain an efficient and light dry air condenser. CHARLES A. PARSONS.

Heaton Works, Newcastle-on-Tyne.

Experiments on Röntgen Rays.

AFTER examining the fluorescent and photographic action of the rays (X_2) emitted on strongly *heating* a "focus tube," and finding them different to the rays which have been hitherto noticed (X_1), in that the relative transparency of flesh, bone, aluminium and glass differs for the two kinds of rays, it seemed desirable to try the effect of cooling the tube. Solid carbon dioxide and ether, and then solid carbon dioxide alone were employed, with the result that in both cases the fluorescence of screen and tube very rapidly died out and the current apparently failed to pass through the latter; as the tube gradually grew warm again, the fluorescence in it returned, not gradually, but very suddenly, at a temperature not very far below that of the room, the glass lighting up brilliantly, and the shadows of the bones showing on the screen with increasing distinctness. The emission of X_1 rays reaching a maximum at about 12° C. (a rough guess). On further heating X_2 rays begin to be evolved, judging from the increasing opacity of the flesh, whilst at the same time the fluorescence excited on the screen grows rather brighter, until the state recorded in my paper of June 4, is reached. As the condition for the maximum of X_1 rays probably varies to a certain extent with the different forms of tube, and even different specimens of the same kind of tube, with the degree of exhaustion, &c., it seems to follow from these experiments that in some cases warming the tube slightly might be useful in photographing the bones, whilst in others moderate cooling would be better; and from the accounts of various operators such would seem to be the case, though, as will be seen in the light of subsequent experiments, the particular method of heating or cooling is an important factor in the result. Solid carbon dioxide seemed very opaque to the rays when its low density is considered, but the effect may have been partly due to the frost condensed upon it from the air.

Wishing to verify for myself the results of other experimentalists, I next examined the tube for its action on a well-insulated brass plate, at first by connecting it with a sensitive electroscope, and afterwards with one of the standard Thomson's quadrant electrometers. As the experiments were all carried out with great care, it may be worth while to state that, using thin aluminium plate well earthed by soldering to a gas-pipe to screen the plate from all ordinary inductive action, the results were that the rays after penetrating $\frac{1}{30}''$ of aluminium, discharged the plate completely, whether electrified positively or negatively, leaving no charge; and that if the plate were uncharged to begin with, it remained uncharged. This result is contrary to that observed by some; but from the delicacy of the instrument used, and the great distance between mirror and scale, there is little room left to doubt the accuracy of this result.

I also tried the effect on a radiometer, making similar experiments with a lampblacked Leslie's cube at about 94° C., and a candle, to see how far radiant energy from these sources was capable of penetrating the large aluminium screens used, in case any heat action might interfere with or mask the effect, and found, as others have, that when perfectly screened from all other action, the radiometer is entirely unaffected by the Röntgen rays, whether they be from a hot or a cold tube. The X-rays are also without action on the blackened face of a thermopile connected with a very sensitive galvanometer.

When the ordinary inductive effects of the tube were *not* screened, I found that the space external to the tube was at a high positive potential, which increased up to contact with the glass of the tube, and was of the same sign all over the bulb part. The cold bulb acted like a positively charged conductor whilst the discharge was passing, and attracted the radiometer arms just as any other charged body would, the effect lasting some time after the discharge stopped. The *unscreened* cold bulb also partly discharged the insulated plate, if the latter were strongly positively charged, it more rapidly discharged it when negatively charged, and left it with a positive charge of the same magnitude to begin with as that left when the plate was strongly positively charged, and lastly in the uncharged plate it developed a positive charge, again of the same magnitude; and this is what would naturally follow from the combination of the Röntgen rays effect with that of ordinary induction.

The X_2 rays seem to discharge a charged plate whether positively or negatively charged, but of this I cannot at present feel quite sure. Aluminium seems so far opaque to them that it is doubtful whether, when a screen is used, any of the rays get through, and when a screen is not used, one cannot feel certain that the effect observed is due to the X_2 rays either wholly or partly. After heating the tube and turning on the current, the whole tube is filled with a whitish, lavender-coloured light, which comes to a focus on the glass behind the kathode, above or below it; and whilst in this state and giving little or no fluorescence on the screen, the tube does *not* charge an *unscreened insulated plate*, but it does rather rapidly drain it of a previously communicated charge, either positive or negative. As the tube cools the lavender light retreats more and more from the kathode till at last it reaches the upper edge of the rectangular anode, when the positive charge, mentioned before, begins to be given to an uncharged insulated plate, but very slowly; as soon as the centre of the anode is bare of the lavender discharge, the potential of the unscreened plate very rapidly rises, and by the time the whole anode is clear of the lavender light the normal positive charge is re-established on the insulated plate. When the lavender glow retires from the kathode, it leaves behind it a space full of almost invisible light, which excites whitish green fluorescence on the glass of the bulb, and it is during this time that most of the rays are X_2, as is shown by the fluorescent screen, and photographs of a hand. I have not yet followed out the changes, relative and absolute, of potential of the anode and kathode, but it would seem almost certain that during the life of the lavender glow the whole tube acts as a relatively good conductor up to the time when the lavender glow crosses the centre of the anode—or the point where the axis of the kathode mirror cuts the anode, when there is an abrupt decrease in conductivity. I intend to investigate this point as soon as possible, and meantime pass on to what I imagine will prove of great use and interest to all who work with these tubes.

During some experiments on the tube with an 18" Wimshurst machine, I noticed that the X_1 rays, *i.e.* those showing the bones best, seemed to be emitted or not according as a brush discharge occurred on the wire leading to the anode of the tube, close to the tube, or not; and that the "electric wind" which blows from the tube as from all charged bodies, seemed also to vary in intensity with the X_1 ray flashes, the X_1 rays being most copiously emitted apparently at the moment when the brush discharge ceased or the wind moderated. I soon found that by making a small brush on the wire near the anode, or drawing

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